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Supplements to Poor Quality Hay for Fattening Cattle

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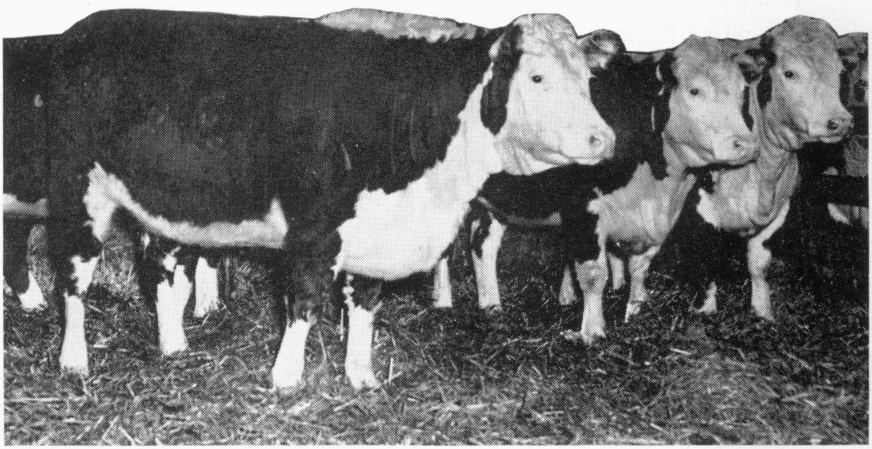

OHIO AGRICULTURAL EXPERIMENT STATION
WOOSTER, OHIO

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SUPPLEMENTS TO POOR QUALITY HAY FOR FATTENING CATTLE

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When cattle are fattened on a full feed of corn, the quality of hay feed is often not given due consideration. This is true because of the relatively small amount of roughage consumed and the belief of some feeders that the quality of roughage fed to fattening cattle is of little importance. The results to be presented show a marked superiority for good quality mixed clover and timothy hay over late-cut timothy when fed with a full feed of corn and cob meal to fattening steers.

Due largely to adverse hay harvesting conditions, large tonnages of late-cut or rain-damaged hay are produced during certain years. It is a common practice to feed such hay to beef cattle. It therefore seemed important to study the nutrient deficiencies of poor-quality hay and determine the most efficient supplement to be fed with such hay. The results of four feeding experiments which were conducted during the period from 1948 to 1952 are presented.

PROCEDURE

The steers used in these experiments were good to choice, grade Hereford steers, purchased on the Kansas City market and shipped by rail to Wooster. The cattle were fed late-cut timothy hay from the time of arrival until the experiments were started. The cattle usually regained their shipping shrink during this period. They were not started on grain feed until after the experiments were begun.

At the start of the experiment, steers were assigned to their respective lots at random within a given weight group. An average of three day weights was used for the initial and final weights and intermediate

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These investigations were initiated by Professor Paul Gerlaugh, who died August 10, 1951. The first three experiments were conducted under his supervision.

weights were obtained every fourteen days. In the first three experiments the finished cattle were sold through packing plants where dressing percentages were obtained. Carcass grades were secured by Professor L. E. Kunkle, of the Meats Laboratory, Ohio State University. The cattle from the fourth experiment were sold through a local sales yard. As a result no slaughter data were available.

Cattle were hand fed twice daily, in groups of 10 to 14 steers, and were in dry lot for the entire feeding period. They were full fed corn and cob meal and given the amount of hay they would eat without waste. All lots were allowed free access to salt and to a mineral mixture of two parts steamed bone meal, two parts ground limestone, and one part salt. Cod liver oil, mixed with corn and cob meal, was fed to all lots in amounts to supply 2,000 International units of vitamin A per 100 pounds of body weight daily. Water was available in tanks at all times.

The poor quality hay fed in these experiments was late cut timothy which was intentionally allowed to weather prior to baling. It was practically devoid of green color but was sufficiently dry when baled that there was no mold or spoilage. The good quality hay was early-cut, mixed clover and timothy, harvested without weathering. The proportions of clover and timothy varied slightly but timothy was always the predominating forage in the mixture. The corn and cob meal fed was ear corn ground through a hammer mill, with a three-eighth inch screen.

The soybean meal used in the first three experiments was solvent extracted meal containing 44 to 46 percent protein. A 41 percent protein expeller meal was fed in the 1951-1952 experiment. The other supplements were of the usual commercial grade except for the trace minerals which were compounded in the laboratory. More detailed information on these feeds is presented in the sections which discuss the individual supplements. The feed prices used in calculating the feed costs per hundred weight of gain, as presented in the various tables are listed in Table 1.

The average daily gains made by the steers in each years experiment were analyzed statistically by analysis of variance. For clarity, however, the results are presented according to the various supplements fed rather than the comparisons made during each individual experiment.

TABLE 1.—Feed Prices Used in Calculation of Costs Per Hundred Weight of Gain

FEED	1948-1949	1949-1950	1950-1951	1951-1952
Corn and cob meal, 70 lb.	$ 1.50	$ 1.50	$ 1.50	$ 1.75
Soybean oil meal, ton	85.00	80.00	80.00	100.00
Hay (Poor quality), ton	15.00	15.00	15.00	25.00
Hay (Good quality), ton	——	——	25.00	30.00
Bone meal, ton	80.00	——	——	——
Limestone, ton	20.00	——	——	——
Salt, ton	30.00	30.00	30.00	30.00
Mineral mixture, ton	——	60.00	60.00	60.00
Meat scraps, ton	130.00	120.00	——	——
Dehydrated alfalfa meal, ton	81.00	90.00	80.00	——
Urea, ton	85.00	——	——	140.00
Dried distillers' solubles, ton	——	110.00	——	——
Corn silage, ton	——	——	12.00	——
Molasses, ton	——	——	86.00	86.00
Trace minerals, pound	——	——	——	0.50*
Molasses ash, pound	——	——	——	0.16

*Price based on laboratory grade chemicals. These minerals could be obtained more economically from various commercial sources.

RESULTS AND DISCUSSION

Value of Meat Scraps in Combination with Soybean Oil Meal

Experiments were conducted during the 1948-1949 and 1949-1950 feeding seasons to determine the value of meat scraps, in combination with soybean oil meal, as a protein supplement for fattening cattle. The meat scraps were included at levels to supply one-sixth, one-third, or one-half of the protein in the supplement. The meat scraps used in the 1948-1949 experiment contained 56.2 percent protein. In 1949-1950 a 50 percent protein meat scrap was fed during the first 100 days and a 62.5 percent grade during the last half of the experiment. The results obtained from these lots of cattle are presented in Table 2.

Although there were some slight variations in daily gains the results presented in Table 2 show no significant differences between soybean oil meal and mixtures of soybean oil meal and meat scraps as protein supplements. Meat scraps apparently supply no factors which are not included in soybean oil meal that will improve a ration containing poor quality hay. Except for a slightly lower average carcass grade, rations which included meat scraps were fully equal to those in which soybean

TABLE 2.—Value of Meat Scraps in Combination With Soybean Oil Meal as a Supplement for Fattening Cattle Fed Poor Quality Hay

		1948-1949 Experiment — 245 days on test				1949-1950 Experiment — 210 days on test	
Lot No.		1	2	3	4	1	7
Source of protein		Soybean oil meal	5/6 soybean oil meal 1/6 meat scraps	2/3 soybean oil meal 1/3 meat scraps	½ soybean oil meal ½ meat scraps	Soybean oil meal	½ soybean oil meal ½ meat scraps
No. steers in lot at start		10	10	10	10	11	10
No. steers in lot at close		10	9	9	10	10	9
Av. weight, start of test		472	472	469	470	625	625
Av. weight, close of test		915	904	923	901	1009	1026
Average daily gain		1.81	1.77	1.85	1.76	1.75	1.80
Av. daily ration:							
Corn and cob meal,	lb.	11.4	11.0	11.2	10.8	13.6	13.4
Supplement,	lb.	1.5	1.5	1.4	1.4	1.5	1.4
Hay,	lb.	2.1	2.1	2.1	2.1	2.2	2.2
Minerals,	oz.	1.4	1.4	1.0	.9	2.3	1.8
Salt,	oz.	.4	.6	.4	.6	.7	.5
Feed per cwt. of gain:							
Corn and cob meal,	lb.	631.0	625.0	606.0	617.0	777.0	743.0
Supplement,	lb.	83.0	82.5	76.5	78.0	86.0	76.0
Hay,	lb.	118.0	121.0	115.0	121.0	127.0	124.0
Minerals,	lb.	5.0	5.0	3.0	3.0	8.0	6.0
Salt,	lb.	1.0	2.0	1.0	2.0	3.0	2.0
Corn and cob meal plus supplement,	lb.	714.0	707.5	682.5	695.0	863.0	819.0
Cost per cwt. of gain		$18.19	$18.34	$17.81	$18.48	$21.31	$20.81
Dressing percent		57.38	58.07	58.37	56.68	61.31	58.91
Carcass grades		6 ch. 4 gd.	4 ch. 4 gd. 1 com.	4 ch. 5 gd.	2 ch. 6 gd. 2 com.	1 ch. 1 ch.— 2 gd.+ 4 gd. 2 gd.—	2 gd.+ 5 gd. 1 gd.— 1 com.

oil meal was the only protein supplement. The relative cost per unit of protein supplied would be the major consideration in determining whether or not a cattle supplement would include some meat scraps.

VALUE OF DEHYDRATED ALFALFA MEAL AS A SUPPLEMENT TO POOR QUALITY HAY

The value of substituting dehydrated alfalfa meal in place of part or all of the soybean oil meal was studied in three of the four experiments. The substitutions were made so that all lots received the same amount of total crude protein. The results obtained in these comparisons are presented in Tables 3 and 4.

The results presented in Table 3 show increased rates of gain as the amount of alfalfa meal fed was increased. The differences in rates of gain in this experiment were not statistically significant, however, until all of the soybean oil meal was replaced by dehydrated alfalfa meal. The difference in average daily gain between Lot 1, fed 1.5 pounds soybean oil meal, and Lot 7, fed 3.4 pounds of alfalfa meal, was highly significant.

TABLE 3.—Value of Dehydrated Alfalfa Meal as a Supplement for Fattening Cattle Fed Poor Quality Hay

	1948-1949 Experiment — 245 days on test			
Lot No.	**1**	**5**	**6**	**7**
Source of protein	**Soybean oil meal**	**2/3 soybean oil meal 1/3 alfalfa meal**	**1/3 soybean oil meal 2/3 alfalfa meal**	**Alfalfa meal**
No. steers in lot at start	10	10	11	11
No. steers in lot at close	10	9	11	10
Av. weight, start of test	472	471	472	472
Av. weight, close of test	915	950	944	994
Av. daily gain, lb.	1.81	1.90	1.93	2.09
Av. daily ration:				
Corn and cob meal, lb.	11.4	11.4	10.9	12.9
Supplement, lb.	1.5	2.2	2.8	3.4
Hay, lb.	2.1	2.3	2.1	2.5
Minerals, oz.	1.4	1.2	.8	1.0
Salt, oz.	.4	.5	.4	.5
Feed per cwt. of gain:				
Corn and cob meal, lb.	631.0	601.0	565.0	618.0
Supplement, lb.	83.0	113.0	145.0	164.0
Hay, lb.	118.0	120.0	110.0	118.0
Minerals, lb.	5.0	4.0	3.0	3.0
Salt, lb.	1 0	2.0	1.0	2.0
Corn and cob meal plus supplement, lb.	714.0	714.0	710.0	782.0
Cost per cwt. of gain	$18.19	$18.68	$19.04	$20.97
Dressing percent	57.38	60.68	59.56	59.85
Carcass grades	6 ch. 4 gd.	7 ch. 2 gd.	9 ch. 2 gd.	7 ch. 3 gd.

In the experiment conducted during 1949-1950, Table 4, the replacement of either one-half or all of the soybean oil meal with dehydrated alfalfa meal brought about a highly significant increase in rate of gain. The difference in average daily gain between the lots fed soybean oil meal and alfalfa meal in the 1950-1951 experiment, Table 4, was also significant. The feeding of alfalfa meal, therefore, significantly increased the rates of gain in all three experiments.

It will be noted in Tables 3 and 4 that as the average daily gains increased the carcass grades were generally higher. The costs per hundred weight of gain were usually increased, however, when alfalfa meal was substituted in place of soybean oil meal. This was due to the relatively high price of alfalfa meal and its lower protein content. It was necessary to feed larger amounts of alfalfa meal to supply the same amount of protein as supplied by soybean oil meal.

TABLE 4.—Value of Dehydrated Alfalfa Meal as a Supplement for Fattening Cattle Fed Poor Quality Hay

	1949-1950 Experiment 210 days on test			1950-1951 Experiment—259 days on test	
Lot No.	**1**	**6**	**5**	**8**	**4**
Source of protein	**Soybean oil meal**	**½ soybean oil meal ½ alfalfa meal**	**Alfalfa meal**	**Soybean oil meal**	**Alfalfa meal**
No. steers in lot at start	11	10	10	12	10
No. steers in lot at close	10	10	10	12	10
Av. weight, start of test	625	631	630	636	632
Av. weight, close of test	1009	1070	1109	1049	1111
Average daily gain	1.75	2 09	2.28	1.60	1.85
Av. daily ration:					
Corn and cob meal, lb.	13 6	14.5	15.9	13.6	15.4
Supplement, lb.	1.5	2.4	3.5	1.5	3.6
Hay, lb.	2.2	2 2	2.2	1.9	1.7
Minerals, oz.	2.3	1.8	2.1	2.0	1.4
Salt, oz.	7	1.1	.5	.5	.6
Feed per cwt. of gain:					
Corn and cob meal, lb.	777.0	692.0	699.0	852.0	833.0
Supplement, lb.	86.0	119.0	153.0	94.0	196.0
Hay, lb.	127.0	106.0	97.0	117.0	90.0
Minerals, lb.	8.0	5.0	6.0	8.0	5.0
Salt, lb.	3.0	3.0	1.0	2.0	2.0
Corn and cob meal plus supplement, lb.	863.0	811.0	852.0	946.0	1029.0
Cost per cwt. of gain	$21.31	$21.00	$22.75	$23.14	$26.51
Dressing percent	61.31	61.98	62.78	59.97	61.36
Carcass grades	1 ch. 1 ch.— 2 gd.+ 4 gd. 2 gd.—	3 ch. 1 ch.— 2 gd.+ 3 gd. 1 gd.—	2 ch. 2 ch.— 5 gd.+ 1 gd.	7 ch. 4 ch.— 1 gd.+	4 pr.— 5 ch.+ 1 ch.

In the 1949-1950 experiment, one lot of cattle was fed the ash of 1.75 pounds of alfalfa meal. The results obtained from this lot are presented in Table 8 with those of cattle fed other trace mineral supplements. Cattle fed this alfalfa ash with soybean oil meal gained at the

rate of 2.19 pounds per head daily as compared to 1.75 pounds for those fed soybean oil meal alone. The cattle fed alfalfa meal gained at the rate of 2.28 pounds daily. There was a highly significant difference between the check lot and either those fed alfalfa meal or those fed alfalfa ash. The difference in daily gain between the alfalfa meal and the alfalfa ash fed cattle was not significant. These results indicate that the minerals present in alfalfa meal were the major factor contributing to the superior performance of cattle fed this feed as compared to soybean oil meal.

UREA AS A SOURCE OF NITROGEN FOR STEERS FATTENED ON A FULL FEED OF CORN AND COB MEAL

Numerous experiments have shown that ruminant animals—cattle and sheep—are able to utilize such non-protein nitrogen as that supplied by urea. The micro-organisms in the paunch or rumen are able to use this non-protein nitrogen to form protein in their own body cells. As these organisms pass through the digestive tract they are broken down, thus freeing for the animal's use the protein which they have synthesized.

The value of urea as a portion of the supplemental nitrogen was investigated in 1948-1949 and 1951-1952. The results of these studies will be found in Tables 5 and 6.

When fed with late-cut timothy hay in 1948-1949 the inclusion of urea tended to reduce the rate of gain and the carcass grade. This was true when urea supplied one-fourth of the supplemental nitrogen. These differences in gain, however, were not statistically significant. When urea supplied one-half of the supplemental nitrogen and was fed with a similar hay in 1951-1952 the rates of gain were identical and the live grades nearly so, with the cattle fed soybean oil meal. When these two rations were fed with good quality mixed hay the gains of the urea-fed cattle were significantly slower and their finished grade was lower (Table 5). The reason for the poorer results when fed with good hay is not apparent.

On the average, the rates of gain of cattle fed urea were slightly lower than those fed soybean oil meal. Much of this difference was due to a considerably slower gain during the early part of the feeding period. Cattle fed urea seemed slower to start on feed. This may be due to the bitter taste of urea.

Urea is a very concentrated source of nitrogen but does not supply energy as do the usual protein supplements. One pound of urea and seven to eight pounds of corn and cob meal are approximately equal

TABLE 5.—Mixtures of Urea and Soybean Oil Meal as Supplements for Fattening Cattle

	Fed with poor hay				Fed with good hay	
	1948-1949 Experiment—245 days on test		1951-1952 Experiment—224 days on test		1951-1952 Experiment—224 days on test	
Lot number	1	10	1	4	6	7
Source of protein	Soybean oil meal	¾ soybean oil meal ¼ Urea	soybean oil meal	½ soybean oil meal ½ Urea	Soybean oil meal	½ soybean oil meal ½ Urea
No. steers in lot at start	10	10	14	13	14	13
No. steers in lot at close	10	10	14	13	14	13
Av. weight, start of test	472	468	472	478	475	474
Av. weight, close of test	915	878	889	895	965	918
Average daily gain, lb.	1.81	1.68	1.86	1.86	2.19	1.98
Av. daily ration,						
Corn and cob meal, lb.	11.4	11.2	11.1	11.9	12.4	12.5
Supplement, lb.	1.5	1.2	1.5	.87	1.5	.87
Hay, lb.	2.1	2.2	2.1	2.4	2.8	3.0
Minerals, oz.	1.4	1.2	1.3	1.5	1.3	1.1
Salt, oz.	.4	.5	.6	.7	.7	.6
Feed per cwt. of gain:						
Corn and cob meal, lb.	631.0	668.0	598.0	637.0	569.0	628.0
Supplement, lb.	83.0	71.0	80.0	46.0	68.0	44.0
Hay, lb.	118.0	128.0	112.0	128.0	127.0	150.0
Minerals, lb.	5.0	5.0	4.0	5.0	4.0	4.0
Salt, lb.	1.0	2.0	2.0	3.0	2.0	2.0
Corn and cob meal plus supplement, lb.	714.0	739.0	678.0	683.0	637.0	672.0
Cost per cwt. of gain	$18.19	$18.56	$20.50	$20.15	$19.69	$20.39
Dressing percentage	57.38	56.54				
			Live grades—graded by Kunkle 7-2-1952			
Carcass grades	6 ch. 4 gd.	3 ch. 6 gd. 1 com.	1 pr. 8 ch. 5 gd.	2 pr. 6 ch. 1 ch.— 4 gd.	9 pr. 5 ch.	2 pr. 1 pr.— 3 ch.+ 4 ch. 3 gd.

to six pounds of soybean oil meal. This relationship and the current market value of these three feeds can be used to determine whether or not urea will be an economical feed.

MIXTURES OF PROTEINS AS SUPPLEMENTS FOR FATTENING CATTLE

The results obtained from feeding various mixtures of proteins to fattening cattle are presented in Table 6.

TABLE 6.—Combination of Proteins as Supplements for Fattening Cattle Fed Poor Quality Hay

	1948-1949 Experiment 245 days on test			1949-1950 Experiment 210 days on test			
Lot number	**1**	**8**	**9**	**1**	**8**	**9**	**10**
SOURCE OF PROTEIN:							
Soybean oil meal	**All**	**1/3**	**1/4**	**All**	**1/2**	**1/4**	**1/4**
Meat scraps		**1/3**	**1/4**			**1/4**	**1/4**
Dehydrated alfalfa meal		**1/3**	**1/4**			**1/4**	**1/4**
Urea			**1/4**				
Dried distillers' solubles					**1/2**	**1/4**	**1/4+ 1# molasses**
No. steers in lot at start	10	11	11	11	11	10	11
No. steers in lot at close	10	10	11	10	10	9	11
Av. weight start of test	472	470	472	625	624	622	630
Av. weight close of test	915	963	903	1009	1039	1028	1104
Average daily gain, lb.	1.81	1.99	1.76	1.75	1.94	1.86	2.26
Average daily ration:							
Corn and cob meal, lb.	11.4	11.6	11.0	13.6	12.9	13.0	14.9
Supplement, lb.	1.5	2.1	1.6	1.5	2.07	2.19	2.19
Hay, lb.	2.1	2.4	2.3	2.2	2.2	2.2	2.2
Molasses, lb.							1.0
Minerals, oz.	1.4	.8	.9	2.3	2.1	2.0	2.0
Salt, oz.	.4	.7	.5	.7	.7	1.5	.7
Feed per cwt. of gain:							
Corn and cob meal, lb.	631.0	580.0	622.0	777.0	663.0	699.0	662.0
Supplement, lb.	83.0	103.0	91.0	86.0	112.0	123.0	100.0
Hay, lb.	118.0	122.0	130.0	127.0	115.0	119.0	98.0
Molasses, lb.							44.0
Minerals, lb.	5.0	3.0	3.0	8.0	7.0	7.0	6.0
Salt, lb.	1.0	2.0	2.0	3.0	2.0	5.0	2.0
Corn and cob meal plus supplement, lb.	714.0	683.0	713.0	863.0	775.0	822.0	762.0
Cost per cwt. of gain	$18.19	$18.29	$18.72	$21.31	$20.86	$22.20	$20.95
Dressing percent	57.38	58.08	58.04	61.31	60.74	60.90	61.05
Carcass grades	6 ch. 4 ga.	6 ch. 4 gd.	3 ch. 7 gd. 1 com.	1 ch. 1 ch.— 2 gd.+ 4 gd. 2 gd.—	1 ch. 2 ch.— 3 gd.+ 3 gd. 1 com.+	1 ch.— 2 gd.+ 5 gd.	3 ch. 4 ch.— 1 gd.+ 3 gd.

Some variations in average daily gains will be noted in the data presented in Table 6. None of these differences were statistically significant, however, except for the gain made by the steers fed molasses in Lot 10 of the 1949-1950 experiments. The difference in average daily gain between the cattle in Lots 9 and 10, fed the same protein supplement but with the addition of one pound of molasses per head daily to Lot 10, was highly significant. The value of adding molasses to a ration containing poor quality hay is discussed in more detail in a later section of this bulletin.

Cattle fed a supplement in which one-half of the nitrogen was supplied by distillers' dried solubles gained at the rate of 1.94 pounds per head daily as compared to 1.75 pounds for cattle fed soybean oil meal. Although the difference between these two lots did not prove to be statistically significant, it approached it very closely. Further investigations would be needed to determine definitely whether or not distillers' dried solubles were of any special value when added to a ration containing poor quality hay.

In general, the results presented in Table 6 show no special advantage for feeding a protein supplement consisting of mixtures of protein feeds.

MOLASSES — A VALUABLE SUPPLEMENT TO RATIONS CONTAINING POOR QUALITY HAY

The value of adding one pound per head daily of cane molasses to rations containing poor quality hay was studied in three experiments. The molasses was fed in the feed bunk with the grain in these experiments and was not sprinkled over the hay. That is, it was not used to increase directly the palatability or consumption of the poor quality hay.

The value of adding molasses to a supplement consisting of four sources of protein was discussed in the preceding section with the results presented in Table 6. The results obtained in three experiments in which all lots were fed soybean oil meal, with and without molasses, are presented in Table 7.

The data in Table 7 show a marked improvement in results when one pound of cane molasses was fed per steer daily. In each experiment the addition of molasses significantly increased the rate of gain and produced cattle with a higher degree of finish. It is interesting to note that in addition to the pound of molasses the cattle fed molasses also ate from 1.3 to 1.8 pounds more corn and cob meal per head daily. There was very little difference between the two lots in the amount of poor quality hay consumed.

In addition to the molasses-fed lot, one lot of cattle was fed the ash of one pound of molasses in the 1951-1952 experiment. The production data for this lot are given in Table 8. The addition of either one pound cane molasses or the ash of one pound molasses significantly increased the gain of cattle fed poor hay and soybean oil meal as the protein supplement. There was a difference of only 0.04 pound in daily gain between the cattle fed molasses and the molasses-ash. These results indicate that the minerals present in cane molasses were the major contributing factor in the improvement of the poor quality hay ration.

TABLE 7.—Value of the Addition of Molasses to Rations Containing Poor Quality Hay for Fattening Cattle

	1949-1950 Experiment—210 days on test		1950-1951 Experiment—259 days on test		1951-1952 Experiment—224 days on test	
Lot number	**1**	**2**	**8**	**9**	**1**	**2**
	Check	**Molasses**	**Check**	**Molasses**	**Check**	**Molasses**
No. steers in lot at start	11	11	12	10	14	13
No. steers in lot at close	10	11	12	10	14	13
Av. weight, start of test	625	624	636	632	472	477
Av. weight, close of test	1009	1070	1049	1127	889	939
Average daily gain, lb.	1.75	2.13	1.60	1.91	1.86	2.06
Average daily ration:						
Corn and cob meal, lb.	13.6	14.9	13.6	15.0	11.1	12.9
Supplement, lb.	1.5	1.5	1.5	1.5	1.5	1.5
Hay, lb.	2.2	2.2	1.9	1.7	2.1	2.2
Molasses, lb.		1.0		1.0		1.0
Minerals, oz.	2.3	2.0	2.0	1.8	1.3	1.2
Salt, oz.	.7	.5	.5	.4	.6	.7
Feed per cwt. of gain:						
Corn and cob meal, lb.	777.0	702.0	852.0	786.0	598.0	624.0
Supplement, lb.	86.0	71.0	94.0	78.0	80.0	72.0
Hay, lb.	127.0	105.0	117.0	91.0	112.0	106.0
Molasses, lb.		47.0		52.0		48.0
Minerals, lb.	8.0	6.0	8.0	6.0	4.0	4.0
Salt, lb.	3.0	2.0	2.0	1.0	2.0	2.0
Corn and cob meal plus supplement, lb.	863.0	773.0	946.0	864.0	678.0	696.0
Cost per cwt. of gain	$21.31	$19.78	$23.14	$23.11	$20.50	$22.75
Dressing percent	61.31	61.49	59.97	62.27		
Carcass grades	1 ch. 1 ch.— 2 gd.+ 4 gd. 2 gd.—	1 ch.+ 2 ch. 3 ch.— 3 gd.+ 1 gd. 1 gd.—	7 ch. 4 ch.— 1 gd.+	1 pr.— 4 pr.— 3 ch. 2 ch.—	**Live grades by Kunkle** 1 pr. 8 ch. 5 gd.	 8 pr. 5 ch.

POOR QUALITY HAY IS DEFICIENT IN TRACE MINERALS

In two experiments the value of adding a complex or trace mineral supplement to the poor quality hay ration was investigated. The mineral mixture fed in the 1949-1950 experiment was as follows:

Sodium bicarbonate (U.S.P.)	200.0 lb.
Trace mineralized salt	100.0
Magnesium sulfate	2.0
Zinc sulfate	0.2

The trace mineralized salt used in this mixture had the following formula:

Cobalt carbonate	0.016 pct.
Copper carbonate	0.060
Manganese carbonate	0.200
Iron oxide	0.260
Potassium iodide	0.010
Hypo-sulfate of soda	0.090
Salt (maximum)	99.364

The above mineral mixture was mixed with the soybean oil meal in amounts to supply each steer 3 ounces of the mixture daily.

The trace minerals fed in 1951-1952 were mixed with finely ground corn and cob meal in such amounts that one pound of the mixture supplied the following amounts of mineral elements per steer daily:

Iron	800 milligrams
Manganese	200
Copper	25
Zinc	14
Cobalt	0.5

In 1949-1950 the ash of 1.75 pounds of dehydrated alfalfa meal per head per day was fed to the steers in Lot 4. The ash of one pound of molasses as obtained from dried molasses fermentation solubles[2] was fed daily to each steer in Lot 3 of the 1951-1952 experiment. Both the alfalfa and molasses ash were weighed out daily and mixed with the day's feed of corn and cob meal. The results obtained from feeding these various mineral supplements are presented in Table 8.

Statistical analysis of the average daily gains presented in Table 8 showed a significant increase due to the feeding of alfalfa ash, molasses ash, or either of the two mineral supplements of known composition. The steers fed alfalfa ash gained slightly faster than those fed trace minerals in the same experiment, a difference which was not significant, however. The gains of steers were identical when fed molasses ash or trace minerals in 1951-1952. These results indicate that the value re-

[2]Curbay B-G, produced by U. S. Industrial Chemicals, Inc., New York, N. Y.

ceived from either the alfalfa or molasses ash was due to one or a combination of the mineral elements present in the prepared mineral supplements. The relationships between alfalfa ash and dehydrated alfalfa meal, and molasses ash and molasses are discussed in those sections of this bulletin which deal with those specific feeds. In both instances the entire feed produced slightly faster gains than the ash but the differences were not statistically significant.

TABLE 8.—Value of Trace Minerals Added to a Ration of Soybean Oil Meal, Corn and Cob Meal and Poor Quality Hay

		1949-1950 Experiment 210 days on test			1951-1952 Experiment 224 days on test		
Lot number		1	4	3	1	3	5
		Check	**Alfalfa ash**	**Trace minerals**	**Check**	**Molasses ash**	**Trace minerals**
No. steers in lot at start		11	10	10	14	13	14
No. steers in lot at close		10	10	10	14	13	14
Av. weight start of test		625	624	630	472	473	471
Av. weight close of test		1009	1084	1063	889	925	924
Average daily gain, lb.		1.75	2.19	2.07	1.86	2.02	2.02
Average daily ration:							
Corn and cob meal,	lb.	13.6	15.4	15.0	11.1	12.3	12.0
Supplement (SBOM)	lb.	1.5	1.5	1.5	1.5	1.5	1.5
Hay,	lb.	2.2	2.2	2.2	2.1	2.4	2.2
Trace minerals,	oz.			3.0			1.1
Molasses ash,	oz.					1.3	
Alfalfa ash,	oz.		2.8				
Minerals,	oz.	2.3	2.1	2.3	1.3	1.3	1.2
Salt,	oz.	.7	.8	.5	.6	.4	.8
Feed per cwt. of gain:							
Corn and cob meal,	lb.	777.0	702.0	729.0	598.0	609.0	596.0
Supplement,	lb.	86.0	69.0	73.0	80.0	74.0	74.0
Hay,	lb.	127.0	102.0	107.0	112.0	117.0	109.0
Trace minerals,	lb.			9.0			3.5
Molasses ash,	lb.					4.0	
Alfalfa ash,			8.0				
Minerals,	lb.	8.0	6.0	7.0	4.0	4.0	4.0
Salt,	lb.	3.0	2.0	2.0	2.0	1.0	3.0
Corn and cob meal plus supplement,	lb.	863.0	771.0	802.0	678.0	683.0	670.0
Cost per cwt. of gain		$21.31	$19.00	$19.83	$20.50	$21.17	$22.13
Dressing percent		61.31	60.58	61.49			
Carcass grades		1 ch. 1 ch.— 2 gd.+ 4 gd. 2 gd.—	1 ch.+ 3 ch. 2 gd.+ 3 gd. 1 gd.—	1 ch. 2 ch.— 4 gd.+ 3 gd.	**Live grades by Kunkle**		
					1 pr. 8 ch. 5 gd.	5 pr. 6 ch. 2 gd.	7 pr. 6 ch. 1 ch.—

APPARENT RELATIONSHIP BETWEEN MOLASSES AND AMOUNT OF SUPPLEMENT FED

In the 1950-1951 experiment three levels of protein (1.5, 0.75 pound or no soybean oil meal per head daily) were fed with good quality mixed clover and timothy hay. Two other lots were fed 1.5 or 0.75 pound soybean oil meal with one pound of cane molasses. The results obtained from these five rations are presented in Table 9.

TABLE 9.—Levels of Soybean Oil Meal, With and Without Molasses, Fed With Good Quality Hay

	1950-1951 Experiment—259 days on test				
	No Molasses			Molasses	
Lot number	**1**	**2**	**3**	**7**	**10**
Soybean oil meal per head per day, lb.	**1.5**	**.75**	**—**	**1.5**	**.75**
No. steers in lot at start	10	10	10	10	10
No. steers in lot at close	10	10	10	10	10
Av. weight start of test	630	630	629	637	637
Av. weight close of test	1132	1093	1050	1154	1168
Average daily gain, lb.	1 94	1.79	1.63	2.00	2.05
Average daily ration:					
Corn and cob meal, lb.	15 0	14.8	15.8	15.0	15.8
Supplement, lb.	1 5	.75		1.5	.75
Hay, lb.	3.3	4.3	4.1	3.0	4.2
Molasses, lb.				1.0	1.0
Minerals, oz.	1.9	1.7	1.8	1.4	1.0
Salt, oz.	.6	1.0	.6	.4	.4
Feed per cwt. of gain:					
Corn and cob meal, lb.	774 0	830.0	974.0	751.0	772.0
Supplement, lb.	77.0	42.0		75.0	37.0
Hay, lb.	169.0	238.0	251.0	149.0	204.0
Molasses, lb.				50.0	49.0
Minerals, lb.	6.0	6.0	7.0	4.0	3.0
Salt, lb.	2.0	4.0	2.0	1.0	1.0
Corn and cob meal plus supplement lb.	851.0	872.0	974.0	826.0	809.0
Feed cost per cwt. of gain	$21.99	$22.67	$24.24	$23.27	$22.77
Dressing percent	63.04	62.33	61.20	61.99	62.99
Carcass grades	6 pr. 4 ch.+	5 pr. 2 ch.+ 3 ch.	2 pr.— 3 ch.+ 4 ch.— 1 gd.	1 pr. 5 pr.— 3 ch.+ 1 gd.	9 pr.— 1 ch.+

It will be noted in Table 9 that, when fed without molasses, the average daily gains and the carcass grades decreased as the amount of soybean oil meal fed was decreased. The difference in average daily gain between Lot 1, fed 1.5 pounds soybean oil meal, and Lot 3, fed no soybean oil meal, was highly significant.

When fed with cane molasses, 0.75 pound of soybean oil meal produced results fully equal to 1.5 pounds. The cattle in Lot 10, fed 0.75 pound soybean meal and 1.0 pound cane molasses produced the highest average carcass grade of all ten lots fed in that year's experiment. The difference in gain, 0.26 pound per head daily, between Lots 2 and 10 fed the same amount of soybean oil meal with and without molasses was statistically significant.

It is important to note that the addition of cane molasses to a ration containing 1.5 pounds soybean oil meal and good quality hay did not improve the results to the extent that it did when added to the same ration fed with poor quality hay (Table 7). In the same year's experiment, the addition of molasses to the poor quality hay ration increased the average daily gain by 0.31 pound but by only 0.06 pound when added to a ration containing good quality hay.

CORN SILAGE IMPROVED RATION WITH POOR QUALITY HAY

In the 1950-1951 experiment, rations containing poor or good quality hay were fed with and without corn silage. Approximately eight pounds of corn silage per head daily were fed to the silage fed lots. The results of these comparisons are given in Table 10.

As shown in Table 10, the addition of corn silage to the poor quality hay ration increased the average daily gains by 0.31 pound—an increase which is highly significant. There was a corresponding decrease in feed cost and amount of feed required per hundred weight of gain and an increase in carcass grade.

The addition of corn silage to a good quality hay ration brought about a slight reduction in feed cost per hundred weight of gain but did not influence the rate of gain significantly. Corn silage was similar to cane molasses in this respect in that it markedly improved the poor hay ration but did not improve a ration containing good quality hay.

In regard to returns per acre of cropland fed to beef cattle, many years of work at the Madison County Farm have shown that the more extensively corn silage is used the greater are the returns.

GOOD QUALITY HAY SUPERIOR TO POOR QUALITY HAY FOR FATTENING CATTLE

In two experiments, direct comparisons were made between lots of cattle fed the same ration except for the quality of hay. The results of these comparisons are listed in Table 11.

TABLE 10.—Value of Corn Silage Fed With Poor or Good Quality Hay

		1950-1951 Experiment 259 days on test			
		Poor hay		Good hay	
Lot number		**8**	**5**	**1**	**6**
		Check	**Silage**	**Check**	**Silage**
No. steers in lot at start		12	10	10	10
No. steers in lot at close		12	10	10	10
Av. weight, start of test		636	630	630	630
Av. weight close of test		1049	1125	1132	1112
Average daily gain, lb.		1.60	1.91	1.94	1.86
Average daily ration:					
Corn and cob meal,	lb.	13.6	13.3	15.0	13.5
Supplement,	lb.	1.5	1.5	1.5	1.5
Hay,	lb.	1.9	1.3	3.3	1.8
Silage,	lb.		7.9		7.9
Minerals,	oz.	2.0	1.7	1.9	.7
Salt,	oz.	.5	.2	.6	.3
Feed per cwt. of gain:					
Corn and cob meal,	lb.	852.0	698.0	774.0	723.0
Supplement,	lb.	94.0	79.0	77.0	80.0
Hay,	lb.	117.0	69.0	169.0	96.0
Silage,	lb.		412.0		422.0
Minerals,	lb.	8.0	6.0	6.0	3.0
Salt,	lb.	2.0	.6	2.0	1.0
Corn and cob meal plus supplement		946.0	777.0	851.0	803.0
Feed cost per cwt. of gain		$23.14	$21.25	$21.99	$22.52
Dressing percent		59.97	62.15	63.04	63.36
Carcass grades		7 ch. 4 ch.— 1 gd.+	2 pr. 3 pr.— 5 ch.+	6 pr. 4 ch.+	1 pr. 5 pr.— 3 ch.+ 1 gd.

In two experiments the feeding of poor quality hay or good quality hay has meant a difference in gain of about one-third of a pound per head daily in favor of the good quality hay. These differences are statistically highly significant. There was also a marked improvement in the carcass grades of the finished cattle. These rations were identical except for the quality of hay fed.

Although all comparisons are not made in any one table, it is of interest that in either of the two experiments the addition of any supplement (dehydrated alfalfa meal, corn silage, cane molasses, molasses ash, or trace minerals) to the poor quality hay ration has not produced gains quite equal to those obtained when good hay was fed. These results

emphasize the importance of producing good quality hay where possible. They also emphasize the value of feeding quality hay to fattening cattle even though only limited amounts are fed with a full feed of corn and cob meal.

TABLE 11.—Value of Quality Hay When Fed With a Full Feed of Corn and Cob Meal to Fattening Cattle

		1950-1951 Experiment—259 days on test		1951-1952 Experiment—224 days on test	
Lot number		**8**	**1**	**1**	**6**
		Poor hay	**Good hay**	**Poor hay**	**Good hay**
No. steers in lot at start		12	10	14	14
No. steers in lot at close		12	10	14	14
Av. weight at start of test		636	630	472	475
Av. weight at close of test		1049	1132	889	965
Average daily gain, lb.		1.60	1.94	1.86	2.19
Average daily ration:					
Corn and cob meal,	lb.	13.6	15.0	11.1	12.4
Supplement,	lb.	1.5	1.5	1.5	1.5
Hay,	lb.	1.9	3.3	2.1	2.8
Minerals,	oz.	2.0	1.9	1.3	1.3
Salt,	oz.	.5	.6	.6	.7
Feed per cwt. of gain:					
Corn and cob meal,	lb.	852.0	774.0	598.0	569.0
Supplement,	lb.	94.0	77.0	80.0	68.0
Hay,	lb.	117.0	169.0	112.0	127.0
Minerals,	lb.	8.0	6.0	4.0	4.0
Salt,	lb.	2.0	2.0	2.0	2.0
Corn and cob meal plus supplement,	lb.	946.0	851.0	678.0	637.0
Cost per cwt. of gain		$23.14	$21.99	$20.50	$19.69
Dressing percent		59.97	63.04		
				Live grades by Kunkle	
Carcass grades		7 ch. 4 ch.— 1 gd.+	6 pr. 4 ch.+	1 pr. 8 ch. 5 gd.	9 pr. 5 ch.

SUMMARY

Four experiments, with approximately 100 steers each, were conducted during the period from 1948 to 1952. These experiments were designed to determine the most efficient supplement to be fed with a full feed of corn and cob meal, soybean oil meal, and late-cut timothy hay to fattening cattle. The results obtained may be summarized as follows:

1) Mixtures of meat scraps and soybean oil meal were approximately equal to soybean oil meal when fed, on an equal protein basis,

with poor quality timothy hay. The relative cost per unit of protein supplied would be the deciding factor in determining whether or not to include meat scraps in a cattle supplement.

2) The gains of the steers were significantly increased when dehydrated alfalfa meal replaced the soybean oil meal. The costs of gains were generally higher, however, because of the higher cost per unit of protein as supplied by the alfalfa meal.

3) Urea proved to be a satisfactory source of nitrogen even though the cattle tended to start on feed more slowly when it was included in the supplement. One pound of urea plus seven to eight pounds of corn and cob meal would be approximately equal to six pounds of soybean oil meal.

4) Various combinations of soybean oil meal, meat scraps, and urea or distillers' dried solubles were not superior to soybean oil meal. When fed in amounts to supply one-half of the supplemental nitrogen, distillers' dried solubles tended to improve the ration but not significantly.

5) The addition of one pound of cane molasses per head daily markedly improved the poor quality hay ration. This was true with respect to the carcass grade of the finished cattle as well as their rate of gain.

6) The ash of dehydrated alfalfa meal, of molasses fermentation solubles or a trace mineral supplement of known composition, significantly increased the gains of steers fed poor quality hay. These results indicate that the poor quality hay ration was deficient in trace minerals and that the minerals present in alfalfa or molasses were the main contributing factors of those feeds.

7) When fed with good quality mixed clover and timothy hay and one pound of cane molasses per head daily, the gains of steers fed three-fourths pound soybean oil meal were equal to those fed one and one-half pounds. This was not true when the same rations were fed without molasses.

8) The addition of eight pounds of corn silage per steer daily to the poor quality hay ration markedly improved the rate of gain and the carcass grade. Corn silage added to a ration which included good quality hay did not increase the gains or the finished grades.

9) There was a highly significant difference in average daily gains between cattle fed good quality, mixed clover and timothy hay and those fed late cut, weathered timothy hay. The results of the four experiments emphasize the value of quality hay as a feed for fattening cattle.